Introduction to Mass Spectrometry

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Introduction to Mass Spectrometry is divided into 20 chapters (covered in 464 pp) written by researchers working in various research laboratories in India. The main theme of the book is to highlight applications of mass spectrometry to the analysis of inorganic and organic compounds. The editors have done an excellent job in presenting various related topics in a simple and concise manner. The treatment of most topics is at a basic level. This should help a beginner to understand the subject with ease. Although the book is mainly targeted to readers of the Indian subcontinent, those new to the subject will benefit equally.

The book opens with a chapter entitled "Introduction to mass spectrometry" written by one of the editors (S.K.A.). This leading chapter provides an overview of various ionization techniques, mass analyzers, detectors, and the technique of isotope dilution mass spectrometry (IDMS) as applied to organic and inorganic mass spectrometry. Although this chapter is easy to read, the discussion about these topics is overly brief, with no figures for visual aid.

Fragmentation of organic compounds is discussed in Chapter 2. Several typical fragmentation processes of organic compounds are explained elegantly with the help of 36 schemes. A procedure for calculation of the abundance of isotope peaks is also described. The usefulness of this chapter would be enhanced if some examples of typical mass spectra and how to interpret them were also included. The next chapter introduces the technique of chemical ionization (CI). The senior author (M. Vairamani) of this chapter is a leading practitioner of CI in India. The first 9 pp of this chapter explains the fundamentals of positive- and negative-ion CI and charge-exchange CI. The remaining 23 pp of the chapter reviews the applications of positive-ion acetone CI. My only criticism of this chapter is that such a lengthy review of the applications of an uncommon reagent gas is inappropriate in an introductory book. Fast-atom bombardment mass spectrometry is the subject of Chapter 4, in which the basic principle of this technique, the design of a typical FAB gun, matrix requirements, and general features of FAB mass spectra are discussed.

Chapter 5 is devoted to liquid chromatography mass spectrometry (LC-MS). In this chapter, the author presents a very brief description of various interfaces, including direct liquid inlet, moving belt, thermospray, continuous-flow FAB, particle beam, and electrospray. The applications section contains some examples of the use of electrospray ionization/LC-MS for the analysis of biomolecules.

The title of the next chapter is "Metastable ions in organic mass spectrometry." In this chapter, the author describes the use of parent ion, daughter ion, and constant neutral loss scans for characterization of metastable ions using double focusing magnetic sector and triple sector quadrupole instruments. However, this chapter could mislead a newcomer into believing that the techniques of metastable ion analysis and collision-activated dissociation (CAD) are one and the same. The two techniques are mixed up in several places. As an example, in the section entitled "Applications of metastable ion spectra," all of the applications discussed are of CAD technique and none of pure metastable ion analysis. Another such confusion is in the section "Metastable ion transition in II FFR." Part of the discussion in this section is about metastable ion analysis by use of the mass-analyzed ion kinetic energy technique, part is about the CAD technique, and the remainder is about the use of a triple sector quadrupole instrument for obtaining the parent ion, daughter ion, and constant neutral loss spectra. Although the same scan laws are used for metastable ion and CAD analyses, the energetics of the ions analyzed are different. The metastable ions are unstable ions, whereas the ions sampled for CAD experiments are stable and contain almost a negligible population of metastable ions. Another weak point of this chapter is that there is no mention of tandem mass spectrometry or of multisector (triple and four sector) and ion trap (both quadrupole and Fourier-transform based) instruments for CAD-MS studies. The technique of neutralization–reionization and its applications are discussed in Chapter 8. This technique is used for studying neutral molecules or radicals produced from mass selected ions. In order to demonstrate the potential of neutralization–reionization for structural studies a few typical examples are also discussed.

The use of mass spectrometry for the analysis of petroleum hydrocarbons is discussed in Chapter 9. This is one of the well-written chapters and contains a comprehensive coverage of this subject. A worker in the petroleum industry will find it an invaluable resource.

Elemental analysis and isotopic ratio measurements are heavily covered in this book. Precise and accurate measurements of the isotope ratio of certain elements are useful in various fields such as nuclear technology, geochronological studies, and agricultural sciences. Several chapters are devoted to this subject. Some of these chapters are well written and worth reading. Chapter 11 illustrates the use of thermal ionization mass

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spectrometry for isotope ratio measurements. The use of spark source and glow discharge mass spectrometry is explained in the next chapter. The principles of isotope dilution mass spectrometry and radiocarbon dating are the focus of Chapters 17 and 18, respectively. Chapter 19 is devoted to the use of stable isotope measurement in agricultural sciences. The use of inductively coupled plasma (ICP) mass spectrometry for elemental and isotopic analysis is presented in Chapter 13. The technique of resonance ionization mass spectrometry is elegantly explained in Chapter 15. This technique can be used for selective detection of elements in a variety of situations.

Time-of-flight (TOF) mass spectrometry has been treated separately in Chapter 16. An excellent discussion of various instrumental aspects of linear TOF and reflectron TOF is provided in this chapter. Applications of TOF-MS to the analysis of clusters are also discussed.

The last chapter addresses the technique of knudsen effusion mass spectrometry. This technique is well suited for investigation of both gas-phase and condensed-phase reactions. This is another excellent chapter and provides a comprehensive discussion of various aspects of the technique and its applications to identification of ionic and neutral species and determination of vapor pressure and various thermodynamic properties of a reaction system.

Other topics included in this book are membrane inlet mass spectrometry, the role of mass spectrometry in drug testing, and applications of secondary ion mass spectrometry in material science. The book also contains two Appendices. One is in a tabulated form, containing useful information regarding isotopes of naturally occurring elements and their abundances. The second Appendix lists the names and addresses of various manufacturers of mass spectrometry systems, and their sales representatives in India.

It is difficult to ignore a few weak points of the book: there is no unified style of writing as is usually the case with a multiauthor compendia. As a consequence, one finds duplication of some topics at several places. One example is the principle of isotope dilution, which is described in at least four different chapters; in the first chapter, the section entitled "Principle of mass spectrometry" discusses the principle of magnetic sector instruments only. This may confuse a novice into believing that these instruments are the only ones used in mass spectrometry. Some other problems: there is no index at the end of the book, which makes it difficult to locate a specific topic; one can find glaring typographical errors at several places in the book; the quality of printing and binding is not up to the mark; and finally, the current focus of mass spectrometry has shifted to biological sciences. This book almost ignores this field. My other criticism of the book is that separate chapters are devoted to CI and FAB, whereas less than a page is devoted to EI, the most commonly used ionization technique for the analysis of inorganic and organic compounds. Similarly, TOF-MS and LC-MS are the focus of two separate chapters, whereas other more commonly used mass analyzers (magnetic sectors, quadrupoles, ion traps, and FT-MS) and gas chromatography–mass spectrometry are discussed rather briefly.

In spite of these minor shortcomings, this book will be a handy resource for someone wishing to learn mass spectrometry. Established researchers in the areas of inorganic and organic mass spectrometry will also find this book a useful addition to their library.